من ذكريات العمل

مشروع قناطر نجع حمادي الجديدة

أعمال الحفر الآمنة في محطة الكهرباء ضد ضغط الرفع(UP-LIFT)

Safety Excavation in Power House against up-lift

أثناء أعمال الإنشاءات في مشروع قناطر نجع حمادي الجديدة، وفي أبريل 2004، أرسل المقاول خطابًا يُعبر فيه عن مخاوفه من حدوث مشكلة في أعمال الحفر نتيجة ضغط الرفع (Up-lift) في منطقة محطة الكهرباء، حيث لم يكن مطمئنًا إلى معامل الأمان (FoS) (Factor of Safety)الذي اعتمد عليه الاستشاري في حساباته. لذا، طلب المقاول اتخاذ إجراءات إضافية لضمان سلامة العمل.

وللتوضيح، فإن موقع العمل كان داخل حفرة الإنشاء (Construction Pit) التي تضم المنشآت الرئيسية للمشروع، وهي محطة الكهرباء، والمفيض، والأهوسة الملاحية.

تحاط حفرة الإنشاء بسد مؤقت يبلغ طوله نحو 2 كيلومتر على منسوب (65.00)، ويحتوي على ستارة من الخرسانة البلاستيكية مكونة من الأسمنت والرمل والبنتونيت، بعمق يصل إلى 55 مترًا، حيث تصل إلى طبقة الطين الصلب(Hard Clay Layer) ، والتي تعمل مع الستارة المؤقتة لحماية منطقة الإنشاء من تسرب المياه.

أعمال حفر الأساسات أسفل المنشآت تختلف من منشأ إلى آخر كما يلي:

- المفيض: (41.90 مترًا فوق مستوى البحر)
- الأهوسة الملاحية: (43.50 مترًا فوق مستوى البحر)
- محطة الكهرباء – منطقة حوض التجميع (Pump Sump): (35.90 مترًا فوق مستوى البحر

بينما كانت مناسيب المياه خارج حفرة الإنشاء تصل إلى (64.50 مترًا).

موقف الاستشاري والمقاول:

ردَّ الاستشاري على المقاول في 22-4-2004 مؤكدًا أن التصميم سليم، وأن نتائج اختبار مقاومة الانضغاط غير المحصورة للطمي والطين مطمئنة، حيث أن معامل الأمان كان أكبر من 1.1، ومع تطبيق الأحمال في وضع ثلاثي الأبعاد (3D) سيرتفع أكثر. وعليه، رأى الاستشاري أنه لا يوجد مبرر فني لرفع المنسوب أو اتخاذ أي إجراءات إضافية، وأرفق بالمراسلة الوثائق الداعمة لرأيه.(مرفق1&2)

في الوقت ذاته، أرسل الاستشاري خطابًا إلى المالك يوضح فيه الموقف تفصيليًا، مشيرًا إلى مراجعة سلامة حفرة البناء (Construction Pit) مع الأخذ في الاعتبار المعلومات الإضافية التي تم الحصول عليها أثناء الإنشاء. وتوصل إلى النتائج التالية بناءً على أقصى منسوب للمياه خارج حفرة الإنشاء (64.5 مترًا):

- معامل الأمان لمنطقة الهويس الملاحي (Navigation Lock) عند أعمق مستوى حفر (43.50 مترًا) كان أكبر من 1.11، وهي نتيجة مرضية.
- معامل الأمان لمنطقة المفيض (Sluice Way) عند أعمق مستوى حفر (41.90 مترًا) كان 1.14، وهي أيضًا نتيجة مرضية.
- معامل الأمان في محطة الكهرباء (Power House) عند أعمق مستوى حفر (35.90 مترًا) تراوح بين 0.96 و1.06. وعادةً، يجب أن يكون (FoS) أعلى من 1.10، لكن انخفاضه قد يكون مقبولًا طالما أن المنطقة المحدودة محليًا.

بناءً على ذلك، اقترح الاستشاري تنفيذ جستين إضافيتين في هذه المنطقة تصلان إلى نهاية الطبقة الصماء (منسوب 6.00 متر) للتحقق من معامل الأمان، مع تقدير تكلفة الأعمال بحوالي 40 ألف جنيه مصري وفقًا لفئات العقد. وافق المالك على الاقتراح، وتم تنفيذ الجستين الإضافيتين.

في 11-08-2004، أرسل الاستشاري خطابًا إلى المقاول، مشيرًا إلى أن نتائج الجسات الإضافية أكدت أن معامل الأمان (FoS) أصبح أكبر من 1.1، وعند تطبيق تأثيرات ثلاثية الأبعاد للاستقرار، سيرتفع بلا شك. وأرفق نتائج الحسابات الداعمة لرأيه. (مرفق رقم 3)

ردود المقاول والاستشاري:

في 2-11-2004، تحفّظ المقاول على نتائج حسابات الاستشاري، مشيرًا إلى أنه بناءً على مراجعة متخصصيه، فإن تقييمهم كالتالي:

- عند مستوى (38.00 مترًا)، كان معامل الأمان ضمن النطاق المقبول.(1.10)
- عند منسوب (36.00 مترًا)، حيث تراوح معامل الأمان بين (1.00 - 1.05)، رأى المقاول أن بعض التدابير الوقائية يجب أن تُتخذ لمنع أي مشاكل ناتجة عن ضغط المياه.(Up-lift)

في 6-11-2004، رد الاستشاري على المقاول ملاحظًا أن الأخير وافق على أن معامل الأمان عند مستوى (38.00 مترًا) مقبول. وأوضح أنه عند منسوب (35.90 مترًا)، فإن تطبيق نظرية التأثيرات ثلاثية الأبعاد (3D)ومع بعض العوامل الأخرى، بالإضافة إلى محدودية مساحة الحفر (18×18 مترًا)، أظهر أن معامل الأمان يتراوح بين (1.4 – 1.5). وحتى بدون تأثير(3D) ، يظل معامل الأمان أعلى من 1.1.

وبناءً على ذلك، أكد الاستشاري أنه بعد إجراء الجستين الإضافيتين، تبيّن عدم وجود خطر من(Up-lift) ، وبالتالي، لا يوجد أي مبرر للقلق. وطالب المقاول بإرسال أي اعتراضات مدعمة بحساباته الفنية في موعد أقصاه 10-11-2004.

والذي يجب أن نتسلمه للمراجعة والتعليق، ليس لاحقًا عن يوم ونصف قبل فترة إغلاق العيد،(كان عيد الفطر في ذلك الوقت) أي بحلول 10 نوفمبر 2004، الساعة 11 ص

وبالتالي، في حال اخترتم إيقاف أعمال الحفر عند مستوى 38.00 متر، بغض النظر عن عدم إرسال ردكم لنا قبل التاريخ المذكور أعلاه، فسيكون ذلك على مسئوليتكم الخاصة وبدون موافقة المالك، وإذا نتج أي تأخير عن هذا القرار من قبل المقاول لن يكون هناك حق في تمديد الوقت، وسيُحمل جميع التكاليف المتعلقة والناتجة عن ذلك بما فيهم اعمال الحزم الأخرى (Lot2,Lot3 and Lot4) وهم شركاء المقاول (Lot1) في المشروع.

وارفق معه الحسابات الدالة على وجهة نظره (مرفقات 4&5&6)

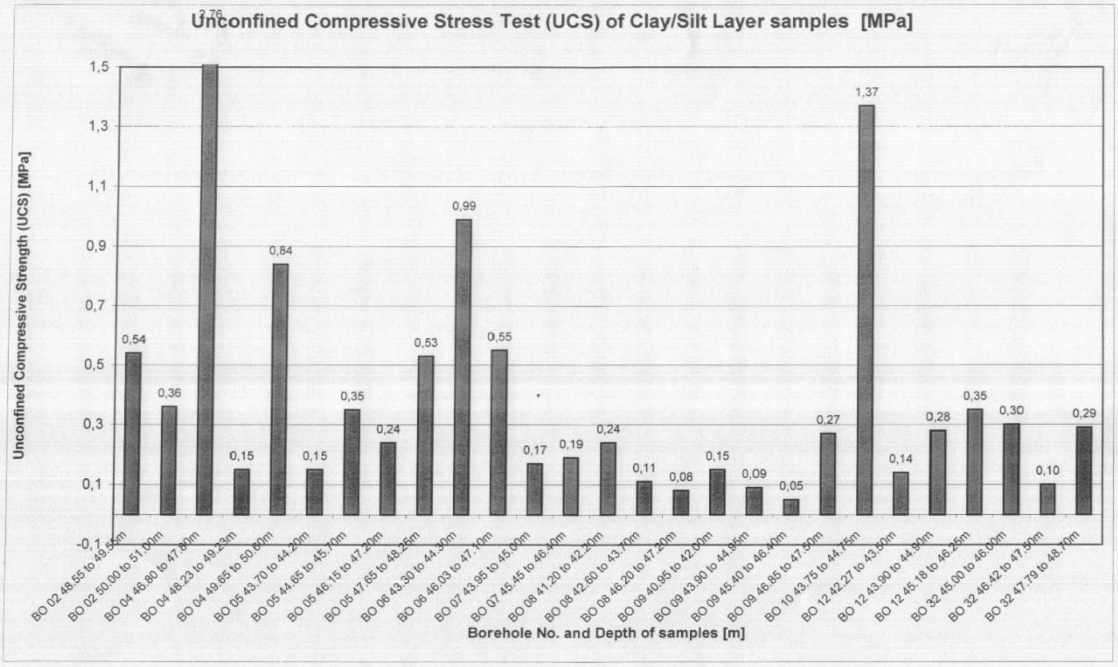
في 9-11-2004، ردَّ المقاول في الموعد المحدد، مؤكدًا أنه بناءً على تأكيد الاستشاري، ليست هناك حاجة لاتخاذ أي احتياطات خاصة أثناء تنفيذ الأعمال. وعليه، استكمل المقاول أعمال الحفر للوصول إلى المناسيب المطلوبة وفقًا للرسومات المعتمدة.

نظرًا لأهمية هذا الموضوع، أعدَّ المهندس صلاح عوض، مدير الأعمال بالمشروع، مذكرة حسابية أكدت صحة حسابات معامل الأمان، والتي بلغت 1.33.

في النهاية، أكمل المقاول الأعمال بنجاح، ولم تحدث أي مشاكل

يبدو أن هذه كانت مناورة ذكية من المقاول لمحاولة دفع المالك إلى تنفيذ أعمال إضافية مكلفة، مع الاحتفاظ بحقه في المطالبة بأي تعويضات أو تمديدات زمنية حال وقوع مشاكل. في المقابل، كان موقف الاستشاري قويًا، معتمدًا على حسابات دقيقة ودراسات فنية دقيقة، مما أدى إلى دحض مخاوف المقاول واستكمال المشروع دون تكاليف إضافية غير مبررة.

هذه محاولة لتسليط الضوء على هذه الفترة الهامة من تنفيذ المشروع، مع تجنب الدخول في تفاصيل فنية دقيقة. ولمن يرغب في المزيد من التفاصيل، يتوفر ملف يحتوي على مذكرة المهندس صلاح عوض، والتي تتضمن الحسابات التفصيلية.



Unconfined Compressive Stress Test (UCS) of Clay/Silt Layer samples [MPa]
Unconfined Compressive Strength (UCS) [MPa]
1,5
1,3
1,1
0,9
0,7
0,5
0,3
0,1
-0,1
0,54
0,36
3,76
0,15
0,84
0,15
0,35
0,24
0,53
0,99
0,55
0,17
0,19
0,24
0,11
0,08
0,15
0,09
0,05
0,27
1,37
0,14
0,28
0,35
0,30
0,10
0,29
BO 02 48.55 to 49.55m
BO 02 50.00 to 51.00m
BO 04 46.80 to 47.80m
BO 04 48.23 to 49.23m
BO 04 49.65 to 50.60m
BO 05 43.70 to 44.20m
BO 05 44.65 to 45.70m
BO 05 46.15 to 47.20m
BO 05 47.65 to 48.25m
BO 06 43.30 to 44.30m
BO 06 46.03 to 47.10m
BO 07 43.95 to 45.00m
BO 07 45.45 to 46.40m
BO 08 41.20 to 42.20m
BO 08 42.60 to 43.70m
BO 08 46.20 to 47.20m
BO 09 40.95 to 42.00m
BO 09 43.90 to 44.95m
BO 09 45.40 to 46.40m
BO 09 46.85 to 47.50m
BO 10 43.75 to 44.75m
BO 12 42.27 to 43.50m
BO 12 43.90 to 44.90m
BO 12 45.18 to 46.25m
BO 32 45.00 to 46.00m
BO 32 46.42 to 47.50m
BO 32 47.79 to 48.70m
Borehole No. and Depth of samples [m]

C.0.W. Trench Excavation / Safety Factor Calculation

Water level below the silt and clay layer = 64.50 asl

	Boreholes										
	BO2	BO4	BO5	BO6	BO7	BO8	BO9	BO10	BO12	B25	B32
	Powerhouse				Sluiceway				Navigation Locks		

	Reference levels										
L1	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50
L2	39,60	39,60	39,60	39,60	48,80	48,80	48,80	48,80	45,10	45,10	45,10
L3	39,10	39,10	39,10	39,10	48,30	48,30	48,30	48,30	44,60	44,60	44,60
L4	13,68	14,22	15,94	17,85	17,58	18,90	18,79	19,55	19,87	20,73	20,57
L5	12,18	12,72	14,44	16,35	16,08	17,40	17,29	18,05	18,37	19,23	19,07
L6	9,18	9,72	11,39	13,35	12,88	12,90	12,29	15,05	15,37	16,72	16,07

L1 = Water level under the silt and clay layer
L2 = Level of the working platform for the trenching of the permanent cut-off wall
L3 = Level of the bentonite slurry in the trench = L2 - 0,50 m
L4 = Top level of the silt and clay layer
L5 = Trenching level / Toe of the permanent cut-off wall
L6 = Bottom level of the silt and clay layer

W0 (in kN/m3) = 10,00 Unit weigth of the water
W1 (in kN/m3) = 19,00 Unit weight of the silt and clay
W2 (in kN/m3) = 10,30 Unit weight of the bentonite
S (in kN/m2) = **50,00** Shear strength of the silt and clay

	Stability of the trench										
F1	1829	1816	1797	1733	2032	2524	2728	1906	1813	1596	1797
F2	1239	1227	1190	1146	1156	1156	1170	1108	1101	1070	1085
SF =	**1,48**	**1,48**	**1,51**	**1,51**	**1,76**	**2,18**	**2,33**	**1,72**	**1,65**	**1,49**	**1,66**

F1 = Total downward holding force = A + B + C where
A = 2,80 x 0,80 (L3 - L5) x W2 (Weight of bentonite slurry)
B = 2,80 x 0,80 x (L5 - L6) x W1 (Weight of silt and clay plug)
C = 2x(2,80+0,80) x (L5 - L6) x S (Shear resistance in silt and clay layer)

F2 = Upward moving force = 2,80 x 0,80 x (L1 - L5) x W0

SF = Safety factor = F1 / F2

Safety against Uplift of Powerhouse Excavation Platforms

Evaluation of Boreholes BO15, BO16, BO17

	Boreholes										
	BO16	BO17	BO16	BO17					BO15	BO15	
	Powerhouse								Pump Sump		

	Reference levels										
	Summer		Winter						Summer	Winter	
L1	64.50	64.50	63.00	63.00					64.50	63.00	
L2	38.00	38.00	38.00	38.00					35.90	35.90	
L3	37.00	37.00	37.00	37.00					34.90	34.90	
L4	15.30	13.99	15.30	13.99					16.53	16.53	
L5	4.75	4.05	4.75	4.05					5.38	5.38	

L1 = Water level under the silt and clay layer
L2 = Excavation level
L3 = Dewatering level below excavation level
L4 = Top level of the silt and clay layer
L5 = Bottom level of the silt and clay layer

W0 (in kN/m3) = 10.00 Unit weigth of the water
W1 (in kN/m3) = 17.00 Unit weight of the dry sand
W2 (in kN/m3) = 20.00 Unit weight of the submerged sand
W3 (in kN/m3) = 19.00 Unit weight of the silt and clay

	Stability of the platform										
F1	651	666	651	666					596	596	
F2	598	605	583	590					591	576	
SF = F1/F2	1.09	1.10	1.12	1.13					1.01	1.03	

F1 = Total downward holding force = A + B + C where
A = (L2 - L3) x W1 (Weight of the dry sand)
B = (L3 - L4) x W2 (Weight of the submerged sand)
C = (L4 - L5) x W3 (Weight of the silt and clay)

F2 = Upward moving force = (L1 - L5) x W0

SF = Safety factor = F1 / F2

Safety against Uplift of Pump Sump Excavation Platform (El. 35.90 m)

3D Effect considered - smallest relevant failure cylinder (inside sump)

	Boreholes	BO15	BO15
	Location	Pump Sump	

	Reference levels	Summer	Winter	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level around pump sump	38.00	38.00	m asl
L2.2	Excavation level at pump sump	35.90	35.90	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of Failure Cylinder			
Dia	Diameter of failure Cylinder	25.45	25.45	m
Ar	Area of failure Cylinder	508.61	508.61	m2
Pe	Perimeter of failure Cylinder	79.94	79.94	m

	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	7.74	7.74	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	91.41	91.41	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A + B + C + D + E + F + G	(Total Downholding Force)	429,716	429,716	kN
A = (L2.2 - L3) * W1 * Ar	(Weight of the dry sand)	8,646	8,646	kN
B = (L3 - L4) * W2 * Ar	(Weight of the submerged sand)	186,863	186,863	kN
C = (L4 - L5) * W3 * Ar	(Weight of the silt and clay)	107,749	107,749	kN
D = Z3/2*(L2.2-L3)*Pe*tan(FA1)	(Friction in perimeter in dry sand)	201	201	kN
E = ((Z3+Z4.1)/2)*(L3-L4)*Pe*tan (FA1)	(Friction in perimeter in wet sand)	47,266	47,266	kN
F = ((Z4.2+Z5)/2)*(L4-L5)*Pe*tan(FA2)	(Friction in perimeter in silt & clay)	61,164	61,164	kN
G = (L4 - L5) * Pe * C1	(Cohesion in perimeter in silt & clay)	17,826	17,826	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Ar	300,689	293,060	kN

	Stability of the platform		
SF = F1/F2		1.43	1.47

SF = Safety factor = F1 / F2

Safety against Uplift of Pump Sump Excavation Platform (El. 35.90 m)

3D Effect considered - largest relevant failure cylinder (outside sump)

	Boreholes							BO15	BO15	
	Location							Pump Sump		

	Reference levels			
		Summer	**Winter**	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level around pump sump	38.00	38.00	m asl
L2.2	Excavation level at pump sump	35.90	35.90	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of the Pump Sump			
X	Length of square area of pump sump bottom	18.00	18.00	m
Y	Length of upper edge of pump sump side slope	24.20	24.20	m

	Geometry of Failure Cylinder			
Dia	Diameter of failure Cylinder	34.40	34.40	m
Ar	Area of failure Cylinder	929.23	929.23	m2
Pe	Perimeter of failure Cylinder	108.05	108.05	m

	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	24.00	24.00	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	107.67	107.67	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A - B + C + D + E + F + G + H	(Total Downholding Force)	765,213	765,213	kN
A = (L2.1 - L3) * W1 * Ar	(Weight of the dry sand incl. volume of the sump)	48,971	48,971	kN
B = (L2.1 - L2.2) * W1 * (X^2 + Y^2) / 2	(Weight of the dry sand within the sump volume)	16,237	16,237	kN
C = (L3 - L4) * W2 * Ar	(Weight of the submerged sand)	341,400	341,400	kN
D = (L4 - L5) * W3 * Ar	(Weight of the silt and clay)	196,858	196,858	kN
E = Z3/2*(L2.1-L3)*Pe*tan(FA1)	(Friction in perimeter in dry sand)	2,610	2,610	kN
F = ((Z3+Z4.1)/2)*(L3-L4)*Pe*tan (FA1)	(Friction in perimeter in wet sand)	84,842	84,842	kN
G = ((Z4.2+Z5)/2)*(L4-L5)*Pe*tan(FA2)	(Friction in perimeter in silt & clay)	82,674	82,674	kN
H = (L4 - L5) * Pe * C1	(Cohesion in perimeter in silt & clay)	24,095	24,095	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Ar	549,363	535,424	kN

	Stability of the platform			
SF = F1/F2		**1.39**	**1.43**	

SF = Safety factor = F1 / F2

Attachment 3

Safety against Uplift of Cut-Off Wall Excavation Trench (El. 36.00 m)

2D Effects considered

	Boreholes								
	Location						BO15	BO15	
							Pump Sump		

	Reference levels	Summer	Winter	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level in the vicinity of cut-off wall excavation trench	38.00	38.00	m asl
L2.2	Excavation level of cut-off wall excavation trench	36.00	36.00	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of the Trench			
Wt	Width of the trench at its top	8.20	8.20	m
Wb	Width of the trench at its bottom	2.80	2.80	m

	Geometry of "Failure Slice"			
Wtr	Width of the "failure slice", perpendicular to the axis of the cut-off wall	14.00	14.00	m
Ttr	Thickness of "failure slice"	1.00	1.00	m
Atr	Area in plan of "failure slice"	14.00	14.00	m2

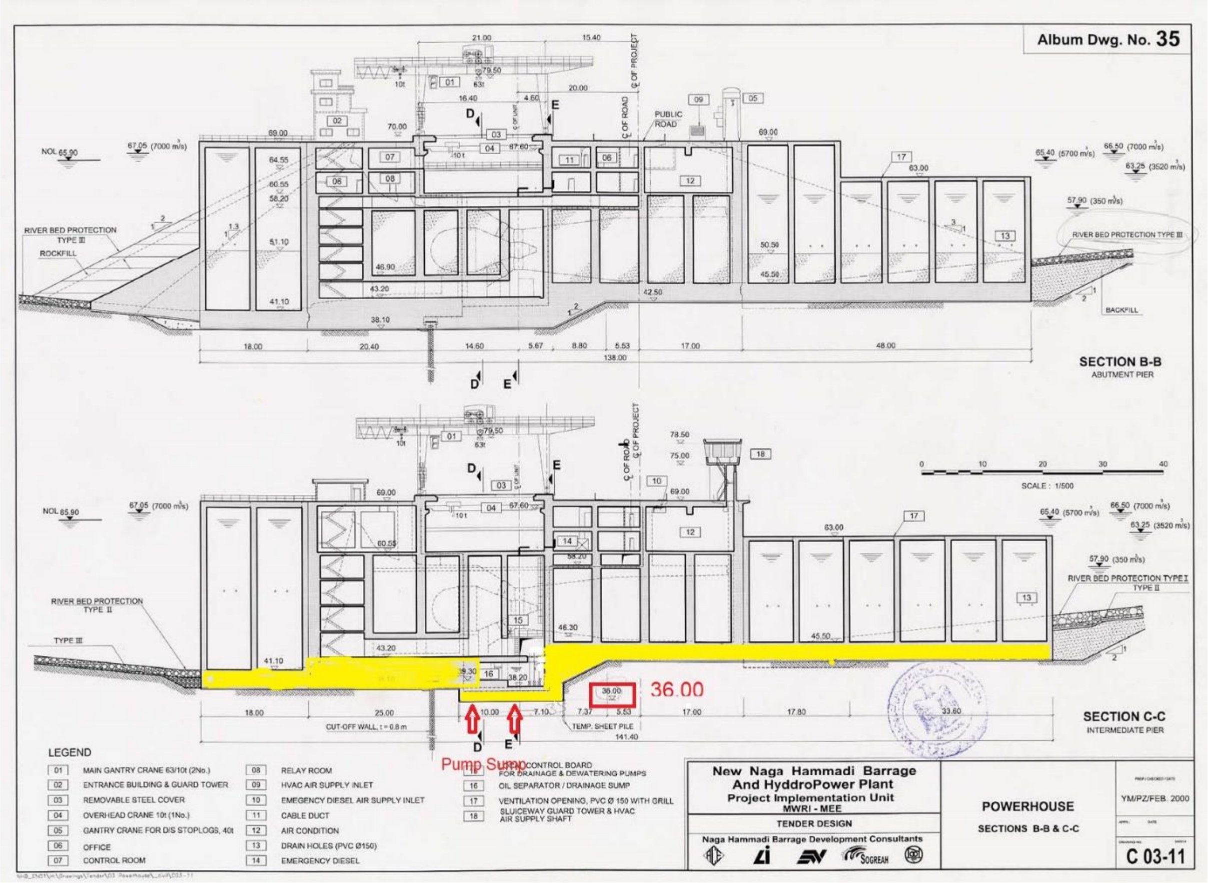
	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	24.00	24.00	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	107.67	107.67	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A - B + C + D + E + F + G + H	(Total Downholding Force)	12,255	12,255	kN
A = (L2.1 - L3) * W1 * Atr	(Weight of the dry sand incl. volume of the trench)	738	738	kN
B = (L2.1 - L2.2) * W1 * (Wt + Wb) / 2 * Ttr	(Weight of the dry sand within the tench volume)	187	187	kN
C = (L3 - L4) * W2 * Atr	(Weight of the submerged sand)	5,144	5,144	kN
D = (L4 - L5) * W3 * Atr	(Weight of the silt and clay)	2,966	2,966	kN
E = Z3/2*(L2.1-L3)*2*Ttr*tan(FA1)	(Friction in perimeter in dry sand)	48	48	kN
F = ((Z3+Z4.1)/2)*(L3-L4)*2*Ttr*tan (FA1)	(Friction in perimeter in wet sand)	1,570	1,570	kN
G = ((Z4.2+Z5)/2)*(L4-L5)*2*Ttr*tan(FA2)	(Friction in perimeter in silt & clay)	1,530	1,530	kN
H = (L4 - L5) * 2 * Ttr * C1	(Cohesion in perimeter in silt & clay)	446	446	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Atr	8,277	8,067	kN

	Stability of the platform			
SF = F1/F2		1.48	1.52	

SF = Safety factor = F1 / F2


Album Dwg. No. 35
SECTION B-B
ABUTMENT PIER
SECTION C-C
INTERMEDIATE PIER
NOL 65.90
67.05 (7000 m³/s)
65.40 (5700 m³/s)
66.50 (7000 m³/s)
63.25 (3520 m³/s)
57.90 (350 m³/s)
RIVER BED PROTECTION TYPE III
ROCKFILL
BACKFILL
RIVER BED PROTECTION TYPE II
RIVER BED PROTECTION TYPE I
TYPE III
PUBLIC ROAD
℄ OF ROAD
℄ OF PROJECT
CUT-OFF WALL, t = 0.8 m
TEMP. SHEET PILE
138.00
141.40
SCALE : 1/500
36.00
Pump Sump
LEGEND
01 MAIN GANTRY CRANE 63/10t (2No.)
02 ENTRANCE BUILDING & GUARD TOWER
03 REMOVABLE STEEL COVER
04 OVERHEAD CRANE 10t (1No.)
05 GANTRY CRANE FOR D/S STOPLOGS, 40t
06 OFFICE
07 CONTROL ROOM
08 RELAY ROOM
09 HVAC AIR SUPPLY INLET
10 EMEGENCY DIESEL AIR SUPPLY INLET
11 CABLE DUCT
12 AIR CONDITION
13 DRAIN HOLES (PVC Ø150)
14 EMERGENCY DIESEL
15 CONTROL BOARD FOR DRAINAGE & DEWATERING PUMPS
16 OIL SEPARATOR / DRAINAGE SUMP
17 VENTILATION OPENING, PVC Ø 150 WITH GRILL
18 SLUICEWAY GUARD TOWER & HVAC AIR SUPPLY SHAFT
New Naga Hammadi Barrage
And HyddroPower Plant
Project Implementation Unit
MWRI - MEE
TENDER DESIGN
Naga Hammadi Barrage Development Consultants
POWERHOUSE
SECTIONS B-B & C-C
YM/PZ/FEB. 2000
C 03-11

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NHBDC/NHBJV/L1/01260 22 April 2004

Gilles Rolland
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Cairo, Egypt

New Naga Hammadi Barrage and Hydropower Plant
Lot 1 – Civil Works

Subject: **Construction Pit – Stability of Working Platforms**

Reference: NH01/NHBDC/C/00942 dated 31 March 2004

Dear Mr. Rolland,

This letter refers to part (1) of the above cited letter. We will refer to part (2) in a separate letter.

Review of "part (1) Cut-Off Wall trench excavation / safety factor calculation" results in the following comments:

Assumptions:

- The readings of the six deep piezometers confirm that an artesian water pressure as given in Volume 4 – Information for Tenderers, article 8.4 is evident. Therefore case 1 is not applicable, as it is on the unsafe side. We consider only case 2 as applicable.

- The unconfined compressive strength test results of the silt and clay are shown in the attached graph. A conservative estimate of a design parameter would be 0,1 Mpa (100 kN/m^2) for the unconfined compressive strength (which is equal to a shear strength of 50 kN/m^2). Furthermore, derivation of the shear strength from uniaxial tests as performed is on the safe side since the in-situ shear strength under triaxial stress conditions is still higher.

Results:

Applying a shear resistance of 50 kN/m^2 for the silt and clay layer, the factor of safety against uplift of the open trench is far above 1.1 for the lower working platforms as shown in the attachment.

Hence, the trench stability is no relevant technical justification to raise the working platform as suggested in your letter.

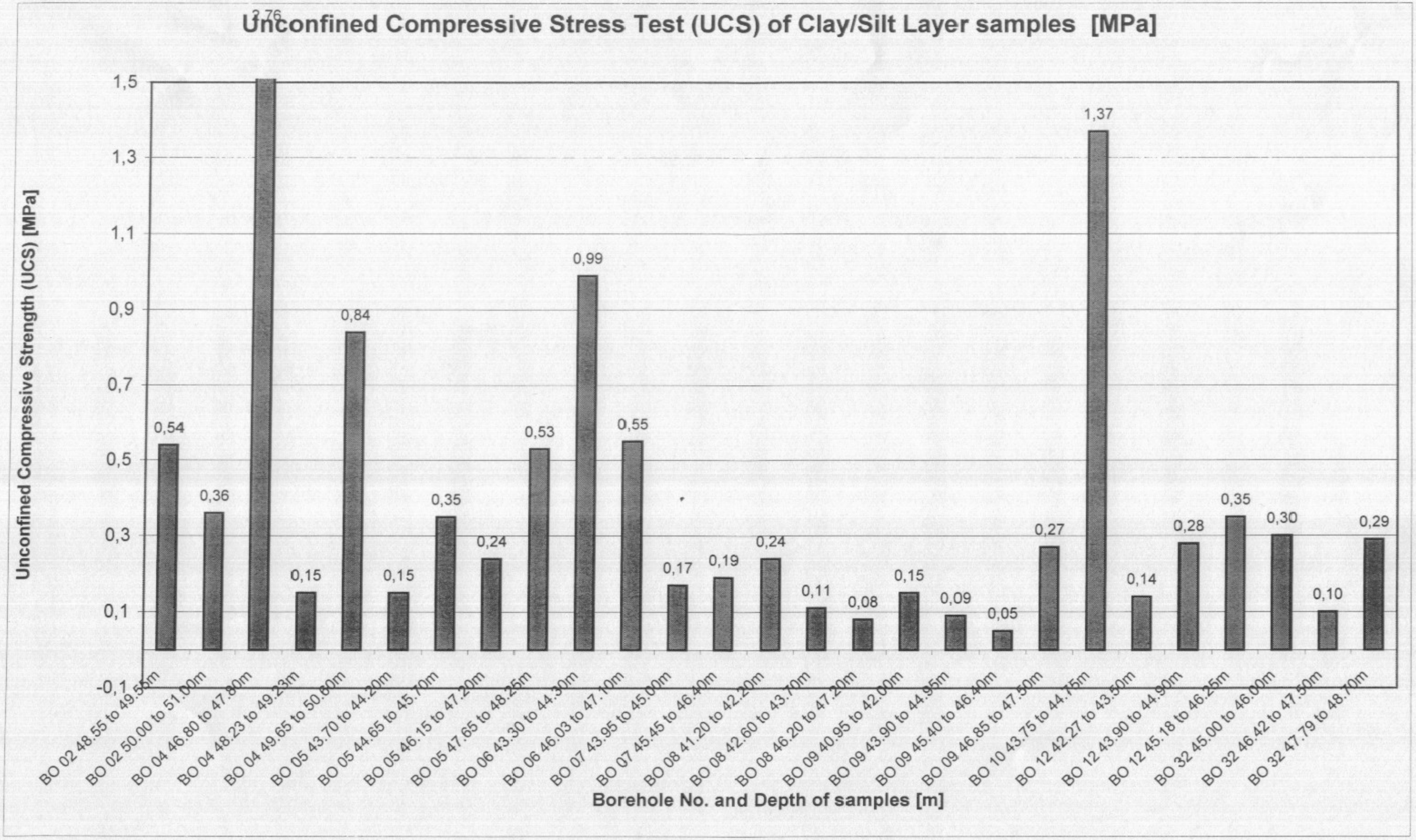
Yours Sincerely,

B. R. Hein
Chief Resident Engineer NHBDC

WG

Attachment: as mentioned above (2 pages)

cc: RGBS-Site: Eng. Mohammed Abd El Aal, RE
NHBDC-Cairo: Dr. J. Kohli, PM


Unconfined Compressive Stress Test (UCS) of Clay/Silt Layer samples [MPa]
Unconfined Compressive Strength (UCS) [MPa]
1,5
1,3
1,1
0,9
0,7
0,5
0,3
0,1
-0,1
0,54
0,36
2,76
0,15
0,84
0,15
0,35
0,24
0,53
0,99
0,55
0,17
0,19
0,24
0,11
0,08
0,15
0,09
0,05
0,27
1,37
0,14
0,28
0,35
0,30
0,10
0,29
BO 02 48.55 to 49.55m
BO 02 50.00 to 51.00m
BO 04 46.80 to 47.80m
BO 04 48.23 to 49.23m
BO 04 49.65 to 50.60m
BO 05 43.70 to 44.20m
BO 05 44.65 to 45.70m
BO 05 46.15 to 47.20m
BO 05 47.65 to 48.25m
BO 06 43.30 to 44.30m
BO 06 46.03 to 47.10m
BO 07 43.95 to 45.00m
BO 07 45.45 to 46.40m
BO 08 41.20 to 42.20m
BO 08 42.60 to 43.70m
BO 08 46.20 to 47.20m
BO 09 40.95 to 42.00m
BO 09 43.90 to 44.95m
BO 09 45.40 to 46.40m
BO 09 46.85 to 47.50m
BO 10 43.75 to 44.75m
BO 12 42.27 to 43.50m
BO 12 43.90 to 44.90m
BO 12 45.18 to 46.25m
BO 32 45.00 to 46.00m
BO 32 46.42 to 47.50m
BO 32 47.79 to 48.70m
Borehole No. and Depth of samples [m]

C.0.W. Trench Excavation / Safety Factor Calculation

Water level below the silt and clay layer = 64.50 asl

	Boreholes										
	BO2	BO4	BO5	BO6	BO7	BO8	BO9	BO10	BO12	B25	B32
	Powerhouse				Sluiceway				Navigation Locks		

	Reference levels										
L1	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50	64,50
L2	39,60	39,60	39,60	39,60	48,80	48,80	48,80	48,80	45,10	45,10	45,10
L3	39,10	39,10	39,10	39,10	48,30	48,30	48,30	48,30	44,60	44,60	44,60
L4	13,68	14,22	15,94	17,85	17,58	18,90	18,79	19,55	19,87	20,73	20,57
L5	12,18	12,72	14,44	16,35	16,08	17,40	17,29	18,05	18,37	19,23	19,07
L6	9,18	9,72	11,39	13,35	12,88	12,90	12,29	15,05	15,37	16,72	16,07

L1 = Water level under the silt and clay layer
L2 = Level of the working platform for the trenching of the permanent cut-off wall
L3 = Level of the bentonite slurry in the trench = L2 - 0,50 m
L4 = Top level of the silt and clay layer
L5 = Trenching level / Toe of the permanent cut-off wall
L6 = Bottom level of the silt and clay layer

W0 (in kN/m3) = 10,00 Unit weigth of the water
W1 (in kN/m3) = 19,00 Unit weight of the silt and clay
W2 (in kN/m3) = 10,30 Unit weight of the bentonite
S (in kN/m2) = **50,00** Shear strength of the silt and clay

	Stability of the trench										
F1	1829	1816	1797	1733	2032	2524	2728	1906	1813	1596	1797
F2	1239	1227	1190	1146	1156	1156	1170	1108	1101	1070	1085
SF =	**1,48**	**1,48**	**1,51**	**1,51**	**1,76**	**2,18**	**2,33**	**1,72**	**1,65**	**1,49**	**1,66**

F1 = Total downward holding force = A + B + C where
A = 2,80 x 0,80 (L3 - L5) x W2 (Weight of bentonite slurry)
B = 2,80 x 0,80 x (L5 - L6) x W1 (Weight of silt and clay plug)
C = 2x(2,80+0,80) x (L5 - L6) x S (Shear resistance in silt and clay layer)

F2 = Upward moving force = 2,80 x 0,80 x (L1 - L5) x W0

SF = Safety factor = F1 / F2

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NHBDC/RGBS/L1/00334 27 April 2004

Eng. Mohammed Abd El Aal
Resident Engineer
RGBS – Site
Naga Hammadi Barrage

New Naga Hammadi Barrage and Hydropower Plant
Lot 1 – Civil Works

Subject: Safety of Excavation Platforms against Uplift

Reference: 1) NH01/NHBDC/C/00942, part (2), dated 31 March 2004
2) NH01/NHBDC/T/01258, dated 21March 2004

Dear Eng Mohammed Abd El Aal,

A review of the safety of the construction pit against uplift considering the additional information obtained during construction and the calculation performed by the Contractor presented in the referred letter 1) resulted in the following findings.

1) The estimated artesian water pressure of 64.5 m asl as given in article 8.4 (2) of Volume 4 – Information to Tenderers is applicable. The estimate is now confirmed by the monitoring of the deep piezometers over one 12 months period and should be applied independently from construction programming to maintain time flexibility in construction and account for the considerably different heads recorded in the six piezometers.

2) FoS Navigation Locks (deepest excavation level 43.50 m asl):
A FoS of > 1.11 is given by two relevant boreholes in the Tender Documents and four relevant boreholes from the construction phase. The boreholes do not puncture the silt and clay layer, so that the FoS can be given only as "greater than".

The result for the navigation lock is satisfactory.

3) FoS Sluiceway (deepest excavation level 41.90 m asl):
A FoS of > 1.14 is given by one relevant borehole and confirmed by five surrounding boreholes in the Tender Documents. Four relevant boreholes from construction phase give a FoS of > 1.11. The boreholes do not puncture the silt and clay layer, so that the FoS can be given only as "greater than"

The result for the sluiceway is satisfactory.

4) FoS Powerhouse (deepest excavation level 38.00 m asl):
Tender Documents: The bottom of the clay layer relevant for safety against uplift in BH26 may be assumed between 2,0 m asl and 8,7 m asl. The respective FoS is given between FoS = 1,13 and FoS = 1,04. The latter elevation was assumed in the referred letter 2). Borehole BH2 in the vicinity also punctures the clay layer and gives a FoS = 1.09. Five surrounding boreholes (not puncturing the silt and clay layer) confirm a FoS > 1.08.

The result is marginal, but satisfactory.

The boreholes drilled during construction along the Cut-Off Wall are too shallow to give additional information for the uplift stability of the excavation area. The respective calculations of the Contractor as submitted in the referred letter are not wrong, but they may be misleading.

5) Pump Sump in Intermediate Pier: (deepest excavation level 35.90 m asl):
There is only one shallow borehole (BO6) drilled during construction at this location and the result as calculated in the referred letter with a FoS > 0.87 is not meaningful due to insufficient depth of the borehole. The deep BH26 in a distance of 40 m gives a FoS = 0.96 or FoS = 1.06 depending how this borehole is assessed.

Normally, the Fos should be above 1.10, but a reduced FoS may be acceptable as long as it is a locally confined area and as long as a FoS > or = 1.00 is confirmed by a borehole. This is not the case at the pump sump location.

6) Additional Investigations:
We propose to drill two offshore boreholes in the location of the pump sump to a depth giving evidence of a FoS of >= 1.0 also locally. This corresponds to a required drilling depth to elevation 6 m asl. With such a drilling depth, the risk to puncture the clay layer is reasonably small. The cost according BoQ items 2.211 and 2.213 would be approximately 40.000 L.E equivalent.

Should the clay layer be encountered at higher elevation, we will design the required measures in the construction sequence of the concreting works to allow for a sufficiently safe excavation of the pump sump by surrounding counterweight.

The performance of the work is only possible before the water level in the Construction Pit is lowered. Therefore, we kindly ask for your approval of our proposal at your earliest convenience.

Yours Sincerely,

B.R. Hein
Chief Resident Engineer

WG

cc: NHBDC-Cairo: Dr. J. Kohli, PM

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— المكتب الفني
— السادة [illegible] / [illegible] [illegible]
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Rec. 4/
3/11/04

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NAGA HAMMADI BARRAGE JV

A joint venture between Vinci Construction Grands Projets / Bilfinger Berger AG / Orascom Construction Industries

Naga Hammadi, 2nd November 2004
NH01/NHBDC/C/02223

Naga Hammadi Barrage Development Consultants
26A Asma Fahmy Street,
Mirghany, Heliopolis, Cairo
Arab Republic of Egypt

Attn.: Chief Resident Engineer, B. R. Hein
Naga Hammadi Barrage Site Office

Distribution: NHBDC: Cairo 1 copy, Site 1 Original
Employer / PIU: RE 1 copy, Dep. RE 1 copy

Dear Sir,

RE.: Construction Pit – Safety of Excavation Platforms against Uplift.

By Consultant's letter NHBDC/NHBJV/L1/01455 dated 2004-08-26, the Contractor was informed about the safety factors against uplift for the excavation of the powerhouse platforms as estimated by the Consultant taking into account the outcome of the latest geotechnical investigations instructed by the Employer.

These safety factors have been thoroughly reviewed by the NHBJV specialists. By reference to internationally accepted standards and previous experience their opinion is as follows:

- At level 38.00m, since the safety factor is within the range of 1.10, this appears acceptable.
- In the sump pit below the intermediate pier (35.90m) and in the trench to be excavated along the cut-off wall (36.00m), since the safety factor mentioned in your letter is in the range 1.00 to 1.05 and even though the 3D effect should improve this factor, we are of the opinion that precaution measures must be implemented to prevent an accidental uplift. We are at your disposal to discuss this matter and suggest some ideas we may have to address this issue.

In any case neither the verification of the stability of the successive construction stages nor the implementation of any precaution measures to prevent uplift form part of the scope of works of the Contractor. Our short term plans are therefore to continue the draw down of the water table in the pit to stabilise it at level 36.50m +/- 0.50m and perform mass excavation down to level 38.00m waiting for the Employer's instructions for further construction stages.

Yours faithfully,

Sylvestre Guillen
Project Manager

Encl.: none.

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NHBDC/NHBJV/L1/01597

06 November 2004

Mr. Sylvestre Guillien
Project Manager
Naga Hammadi Barrage JV
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2nd Floor Office # 36
Al Tahrir Square, Cairo, Egypt

New Naga Hammadi Barrage and Hydropower Plant

Lot 1 – Civil Works

Subject: **Construction Pit – Safety of Excavations Platforms against Uplift**

Reference:
(1) NHBJV's Ref. NH01/NHBDC/T/01469 dated 17 July 2004
(2) Our Ref. NHBDC/NHBJV/L1/01445 dated 26 August 2004 (erroneously referred to by NHBJV as "NHBDC/NHBJV/L1/01455")
(3) NHBJV's Ref. NH01/NHBDC/C/02223 dated 02 November 2004

Dear Mr. Guillien,

We refer to the above mentioned subject and hereby respond to your correspondence (3), by which you informed us of your concern regarding the safety against uplift of excavations platforms in the Construction Pit. With regard to the related opinion of your experts as stated in your a/m letter, we hereby advise you as follows:

- It is noted that you concur with us that the safety factor at level 38.00 m, which is within the range of 1.10, is acceptable.
- The importance of the 3D effects, which are governing the stability against uplift in pump sump pit below the intermediate pier, is demonstrated by the attached calculation sheets, which were prepared for checking the stability of the following two failure cylinders: a) the smallest relevant cylinder, whose area in plan encircles the entire bottom area of the sump pit, with a surface level taken on the safe side as 35.90 m (Attachment 1), and b) the largest relevant cylinder, whose area in plan encircles the outer edges of sump pit slopes, where the surface level is at 38.00 m (Attachment 2). It is shown that safety factors are within 1.40 to 1.50, which is acceptable taking into account 3D effects. Nevertheless, in addition to code requirements, and as already informed by our letter (2), even when disregarding the 3D effect, safety factors are still above 1.00.
- The stability against uplift in the excavation trench along the cut-off wall, is determined by considering 2D effects, as documented by Attachment 3. The stability check has been performed for a "failure slice", whose width is taken as five times the bottom width of the trench, which is deemed reasonable. The resulting safety factors are within the range of 1.50, which is safe.

Safety against Uplift of Pump Sump Excavation Platform (El. 35.90 m)

3D Effect considered - smallest relevant failure cylinder (inside sump)

	Boreholes	BO15	BO15
	Location	Pump Sump	

	Reference levels			
		Summer	**Winter**	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level around pump sump	38.00	38.00	m asl
L2.2	Excavation level at pump sump	35.90	35.90	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of Failure Cylinder			
Dia	Diameter of failure Cylinder	25.45	25.45	m
Ar	Area of failure Cylinder	508.61	508.61	m2
Pe	Perimeter of failure Cylinder	79.94	79.94	m

	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	7.74	7.74	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	91.41	91.41	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A + B + C + D + E + F + G	(Total Downholding Force)	429,716	429,716	kN
A = (L2.2 - L3) * W1 * Ar	(Weight of the dry sand)	8,646	8,646	kN
B = (L3 - L4) * W2 * Ar	(Weight of the submerged sand)	186,863	186,863	kN
C = (L4 - L5) * W3 * Ar	(Weight of the silt and clay)	107,749	107,749	kN
D = Z3/2*(L2.2-L3)*Pe*tan(FA1)	(Friction in perimeter in dry sand)	201	201	kN
E = ((Z3+Z4.1)/2)*(L3-L4)*Pe*tan (FA1)	(Friction in perimeter in wet sand)	47,266	47,266	kN
F = ((Z4.2+Z5)/2)*(L4-L5)*Pe*tan(FA2)	(Friction in perimeter in silt & clay)	61,164	61,164	kN
G = (L4 - L5) * Pe * C1	(Cohesion in perimeter in silt & clay)	17,826	17,826	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Ar	300,689	293,060	kN

	Stability of the platform		
SF = F1/F2		**1.43**	**1.47**

SF = Safety factor = F1 / F2

We trust that it has now been sufficiently substantiated that there is no risk of accidental uplift, and, consequently, there is no basis for any concern to excavate the entire construction pit down to the lines as shown on the drawings. Thus, you may choose the sequence of construction, which you consider most appropriate to complete the works within the time frame of agreed key dates.

Considering the above, there is no need to reduce pumping prior to reaching the target water table in the pit, as defined by the PTS, nor is it justifiable to hold the excavation works at level 38.00 m. The Employer/Consultant will presume that you concur with our conclusions, unless you will provide us with your response, which shall be well substantiated by your own calculation details, and which shall be received by us for review and comment, not later than one and half day before the El-Eid closure period, i.e. by 10 November 2004, 11 am.

Consequently, in case that you should choose to hold the excavation works at el. 38.00 m, or to unnecessarily slow down pumping prior to reaching the target water table, irrespective of not having sent to us your response prior to the aforementioned date, this will be on your own responsibility and without the Employer's approval. Please be advised that, should any delays result from such decision by NHBJV, there will be no entitlement for extension of time, and all related consequential costs, incurred to NHBJV and to the Contractors of other Lots, shall be on NHBJV's account.

Yours Sincerely,

R. Schmidt

For: B. R. Hein
Chief Resident Engineer

RS, BT

Encl.:

Attachment 1: Safety against Uplift of Pump Sump Excavation Platform, 3D Effect considered - smallest relevant failure cylinder (inside sump)

Attachment 2: Safety against Uplift of Pump Sump Excavation Platform, 3D Effect considered - largest relevant failure cylinder (outside sump)

Attachment 3: Safety against Uplift of Cut-Off Wall Excavation Trench, 2D Effects considered

cc: RGBS Eng. Mohammed Abd El Aal, Resident Engineer
Cairo: NHBDC Dr. J. Kohli, PM
TE, WZ

Attachment 2

Safety against Uplift of Pump Sump Excavation Platform (El. 35.90 m)

3D Effect considered - largest relevant failure cylinder (outside sump)

	Boreholes							BO15	BO15	
	Location							Pump Sump		

	Reference levels			
		Summer	Winter	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level around pump sump	38.00	38.00	m asl
L2.2	Excavation level at pump sump	35.90	35.90	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of the Pump Sump			
X	Length of square area of pump sump bottom	18.00	18.00	m
Y	Length of upper edge of pump sump side slope	24.20	24.20	m

	Geometry of Failure Cylinder			
Dia	Diameter of failure Cylinder	34.40	34.40	m
Ar	Area of failure Cylinder	929.23	929.23	m2
Pe	Perimeter of failure Cylinder	108.05	108.05	m

	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	24.00	24.00	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	107.67	107.67	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A - B + C + D + E + F + G + H	(Total Downholding Force)	765,213	765,213	kN
A = (L2.1 - L3) * W1 * Ar	(Weight of the dry sand incl. volume of the sump)	48,971	48,971	kN
B = (L2.1 - L2.2) * W1 * (X^2 + Y^2) / 2	(Weight of the dry sand within the sump volume)	16,237	16,237	kN
C = (L3 - L4) * W2 * Ar	(Weight of the submerged sand)	341,400	341,400	kN
D = (L4 - L5) * W3 * Ar	(Weight of the silt and clay)	196,858	196,858	kN
E = Z3/2*(L2.1-L3)*Pe*tan(FA1)	(Friction in perimeter in dry sand)	2,610	2,610	kN
F = ((Z3+Z4.1)/2)*(L3-L4)*Pe*tan (FA1)	(Friction in perimeter in wet sand)	84,842	84,842	kN
G = ((Z4.2+Z5)/2)*(L4-L5)*Pe*tan(FA2)	(Friction in perimeter in silt & clay)	82,674	82,674	kN
H = (L4 - L5) * Pe * C1	(Cohesion in perimeter in silt & clay)	24,095	24,095	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Ar	549,363	535,424	kN

	Stability of the platform									
SF = F1/F2								**1.39**	**1.43**	

SF = Safety factor = F1 / F2

Attachment 3

Safety against Uplift of Cut-Off Wall Excavation Trench (El. 36.00 m)

2D Effects considered

	Boreholes						BO15	BO15	
	Location						Pump Sump		

	Reference levels	Summer	Winter	
L1	Water level under the silt and clay layer	64.50	63.00	m asl
L2.1	Excavation level in the vicinity of cut-off wall excavation trench	38.00	38.00	m asl
L2.2	Excavation level of cut-off wall excavation trench	36.00	36.00	m asl
L3	Dewatering level below excavation level	34.90	34.90	m asl
L4	Top level of the silt and clay layer	16.53	16.53	m asl
L5	Bottom level of the silt and clay layer	5.38	5.38	m asl

	Geometry of the Trench			
Wt	Width of the trench at its top	8.20	8.20	m
Wb	Width of the trench at its bottom	2.80	2.80	m

	Geometry of "Failure Slice"			
Wtr	Width of the "failure slice", perpendicular to the axis of the cut-off wall	14.00	14.00	m
Ttr	Thickness of "failure slice"	1.00	1.00	m
Atr	Area in plan of "failure slice"	14.00	14.00	m2

	Soil-Mechanic Parameters			
W0	Unit weigth of the water	10.00	10.00	kN/m3
W1	Unit weight of the dry sand	17.00	17.00	kN/m3
W2	Unit weight of the submerged sand	20.00	20.00	kN/m3
W3	Unit weight of the silt and clay	19.00	19.00	kN/m3
FA1	Friction angle of the sand	33.00	33.00	°
FA2	Friction angle of the silt and clay	20.00	20.00	°
C1	Cohesion of the silt and clay	20.00	20.00	kN/m2

	Lateral Earth Pressure			
Z1.1	Lateral earth pressure coefficient (1-sin (phi)) in sand	0.46	0.46	-
Z1.2	Lateral earth pressure coefficient (1-sin (phi)) in silt and clay	0.66	0.66	-
Z3	Lateral Earth Pressure at elevation L3	24.00	24.00	kN/m2
Z4.1	Lateral Earth Pressure at elevation L4 (sand)	107.67	107.67	kN/m2
Z4.2	Lateral Earth Pressure at elevation L4 (silt & clay)	155.56	155.56	kN/m2
Z5	Lateral Earth Pressure at elevation L5	221.60	221.60	kN/m2

	Lateral Earth Pressure			
F1 = A - B + C + D + E + F + G + H	(Total Downholding Force)	12,255	12,255	kN
A = (L2.1 - L3) * W1 * Atr	(Weight of the dry sand incl. volume of the trench)	738	738	kN
B = (L2.1 - L2.2) * W1 * (Wt + Wb) / 2 * Ttr	(Weight of the dry sand within the tench volume)	187	187	kN
C = (L3 - L4) * W2 * Atr	(Weight of the submerged sand)	5,144	5,144	kN
D = (L4 - L5) * W3 * Atr	(Weight of the silt and clay)	2,966	2,966	kN
E = Z3/2*(L2.1-L3)*2*Ttr*tan(FA1)	(Friction in perimeter in dry sand)	48	48	kN
F = ((Z3+Z4.1)/2)*(L3-L4)*2*Ttr*tan (FA1)	(Friction in perimeter in wet sand)	1,570	1,570	kN
G = ((Z4.2+Z5)/2)*(L4-L5)*2*Ttr*tan(FA2)	(Friction in perimeter in silt & clay)	1,530	1,530	kN
H = (L4 - L5) * 2 * Ttr * C1	(Cohesion in perimeter in silt & clay)	446	446	kN
F2 =	Upward moving force = (L1 - L5) * W0 * Atr	8,277	8,067	kN

	Stability of the platform								
SF = F1/F2							1.48	1.52	

SF = Safety factor = F1 / F2

Rec. 9/11/04

BILFINGER BERGER   VINCI CONSTRUCTION GRANDS PROJETS   ORASCOM CONSTRUCTION INDUSTRIES

NAGA HAMMADI BARRAGE JV

A joint venture between Vinci Construction Grands Projets / Bilfinger Berger AG / Orascom Construction Industries

Naga Hammadi, 09 November 2004
NH01/NHBDC/C/02258

Naga Hammadi Barrage Development Consultants
26 A Asma Fahmy Street,
Mirghany, Heliopolis,
Cairo, Arab Republic of Egypt

Attn.: Chief Resident Engineer, B. R. Hein
Naga Hammadi Barrage Site Office

Distribution: NHBDC Site 1 original, Cairo 1 copy
Employer/PIU, RE 1 copy, Dep. RE 1 copy

Dear Sirs,

RE: Construction Pit – Safety of Excavation Platforms against Uplift

We refer to your letter NHBDC/NHBJV/L1/01597 dated 2004-11-06 concerning the above.

Your letter confirms that there is no requirement for special precautions to be taken by the Contractor in safeguarding the excavation platforms against potential uplift during the execution of the Works.

In view of this confirmation we shall continue with the excavation works to attain the lines and grades shown on the approved for construction drawings.

Yours faithfully,

Sylvestre Guillien
Project Manager

ST

Encl: none

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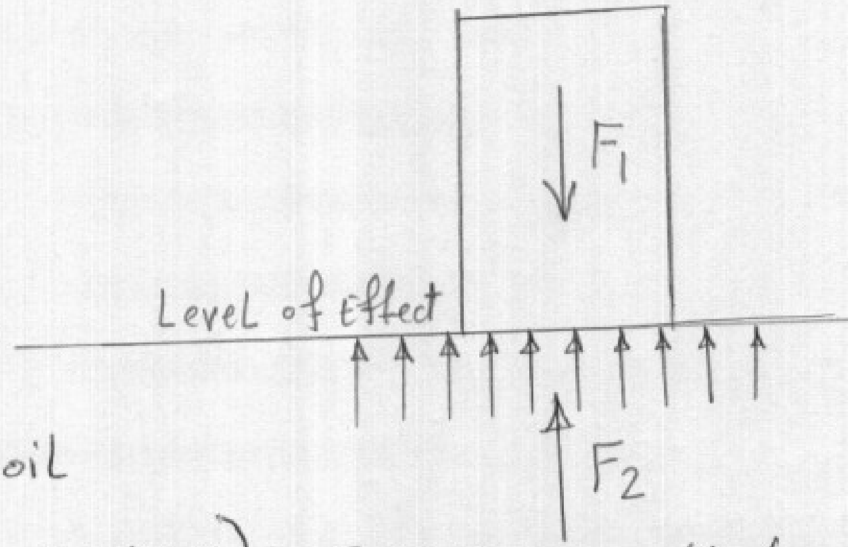
Safety of Excavations platforms against uplift

The safety factor $= \dfrac{\text{Total Downholding force}(F_1)}{\text{upward moving force }(F_2)}$



F_1 = weight of soil

+(Cohesion + Friction) in Case of 3D effect.

F_2 = Arteizen water pressure.

There are 2 Methods for calculation of the safety factor in Case of a Cubic or prizemtic pit Such a pump sump

1- 2 Dimension effects

2- 3 Dimension effects.

- in Case of 2D effects only the down holding forces resulting from the weight of Soils and Cohesion are considered for Calculation (F_1)
- In Case of 3D effects The forces resulting from the weight of Soil in addition to the the forces Resulting from the lateral earth pressure and Cohesion are Considered for Calculation (F_1)

Safety against uplift of pump sump Excavation platform at Powerhouse area (3D Effect)

there are 2 cases are considered :-

1- Smallest relevant failure cylinder (inside Sump)
2- Largest relevant failure cylinder (outside Sump)

taking into Consideration Case 2 which represents the worst Case for Calculations.

$F_1 = A - B + C + D + E + F + G + H$ (Total Down force)

where A = weight of dry Sand including the volume of the sump

B = Weight of the dry Sand within the sump volume

C = " " " Submerged Sand.

D = " " " Silt and Clay.

E = Friction in perimeter in dry Sand

F = Friction in perimeter in wet Sand

G = Friction in perimeter in Silt and clay

H = Chesion in perimeter in Silt and clay.

F_2 = Upward moving force =
= (Artezen level – Level of effect) X Unit weight of water

X Area of failure cylinder.

for 3D effect the factor of safety $= \frac{F_1}{F_2} \geq 1.4$

- to Calculate the factor of Safety some informations needed from the field and from the lab. and from Long experciences. those informations are.

- **Levels**

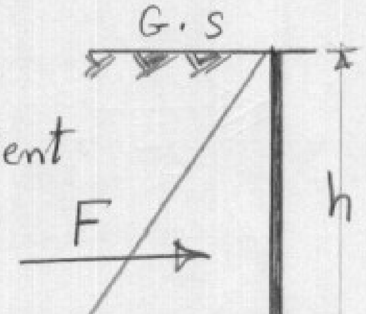
- Water level under the silt and clay layer.
- Excavation Level around pump sump
- " " at pump sump
- Dewatering level below excavation Level.
- Top Level of the silt and clay Layer
- bottom level of the silt and clay layer.

- **Soil-Mechanic parameters.**

- Unit weight of the water (W_0)
- " " " dry Sand (W_1)
- " " " Saturated Sand (W_2)
- " " " Silt and clay (W_3)
- Friction angle of the Sand (FA_1)
- Friction angle of the silt and clay (FA_2)
- Cohesion of the silt and clay (C_1)

- **Lateral Earth pressure.**

$Z = Ka \times W \times h$



Ka = Lateral earth pressure cofficient
$= 1 - \sin F_A$

where F_A = Friction angle of Soil

W = unit weight of soil.

h = difference in Levels.

$$F = \frac{1}{2} \times z \times h$$

Downholding Load = F fam F_A

- It must be noted that W is considerd according to the Soil Condition (dry or wet) if the soil is saturated.

submerged weight is considered -

$$\gamma_{sub} = \gamma_{sat} - \gamma_w$$

Calculations

Consider the Largest relevant failure cylinder with diameter equal to $25\sqrt{2} = 35.35$

		a.S.L
L_1	= Water level under the silt and clay layer	(64.50)
$L_{2.1}$	= Excavation level around pump sump	(38.00)
$L_{2.2}$	= Excavation " at pump sump	(35.90)
L_3	= Dewatering level below excavation level	(34.90)
L_4	= Top level of the silt and clay layer	(16.50)
L_5	= Bottom level of the silt and clay layer	(6.50)

Geometry of the pump sump

X = Length of the square area of pump sump bottom = 18.0 m

Y = Length of the square area of upper edge of pump sump side slope = 25.0 m

Geometry of failure cylinder.

Dia = diameter of failure cylinder = $25\sqrt{2}$ = 35.35 m

Ar = Area of failure cylinder = 981.1 m^2

Pe = Perimeter of failure cylinder = 110.99 ≃ 111.0 m

Soil Mechanic parameters

W0 = Unit weight of water = 10 KN/m^3

W1 = " " dry Sand = 17 KN/m^3

W_2 = " " " Saturated Sand = 20 KN/m^3

W_3 = " " " Silt and clay = 19 KN/m^3

FA_1 = Friction angle of Sand = 33°

FA_2 = " " " Silt and clay = 20°

C_1 = Cohesion of Silt and clay = 20 KN/m^2

$D = (L_4 - L_5) \times W_3 \times Ar$

$= 10 \times 19 \times 981.1 \qquad = 186409 \text{ KN}$

$E = \frac{Z_3}{2} \times (L_{2.1} - L_3) \times P_c \tan(FA_1)$.

$= \frac{24}{2} \times 3.1 \times 111 \times \tan 33^\circ \qquad = 2680 \text{ KN}$

$F = \frac{(Z_3 + Z_{4.1})}{2} \times (L_3 - L_4) P_e \tan FA_1$

$= \frac{24 + 107.6}{2} \times 18.37 \times 111 \tan 33 = 87125 \text{ KN}$

$G = \frac{Z_{4.1} + Z_5}{2} \times (L_4 - L_5) \times P_e \times \tan FA_2$

$= \frac{107.6 + 232.62}{2} \times 10 \times 111 \tan 20 = 68726 \text{ KN}$

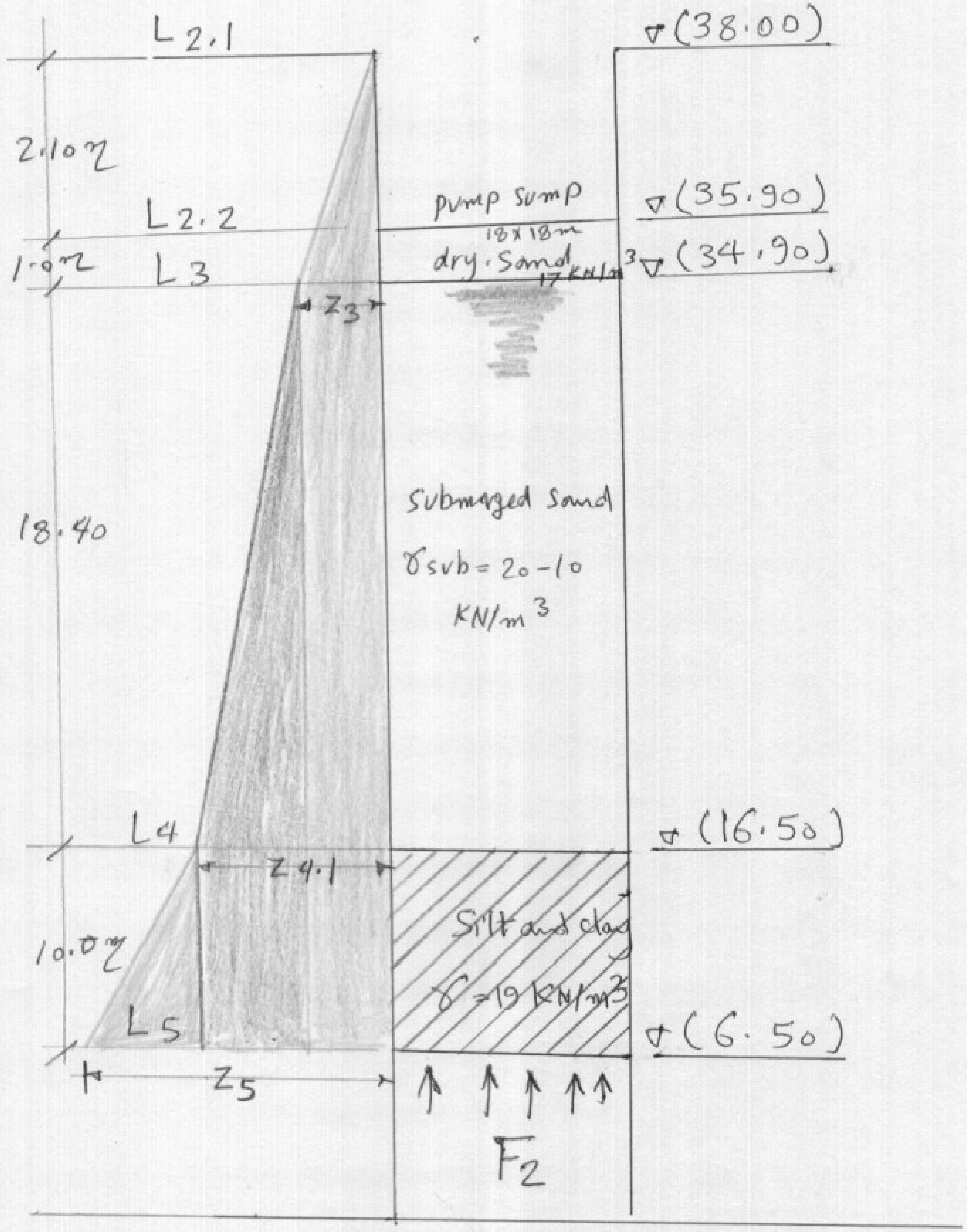
$H = (L_4 - L_5) \times P_e \times C_1$

$= 10 \times 111 \times 20 \qquad = 22200 \text{ KN}$

F_2 = upward moving force $= (L_1 - L_5) \times W_0 \times Ar$

$= (64.5 - 6.50) \times 10 \times 981.1 = 569038 \text{ KN}$

factor of saftey $= \frac{F_1}{F_2} = 1.339$



Saftey against up left of pump sump in Power house area.

Lateral earth pressure.

$Z_{1.1}$ = lateral earth pressure Cofficient $(1-\sin FA_1) = 0.455$

$Z_{1.2}$ = " " " " $(1-\sin FA_2) = 0.658$

Z_3 = " " " at elevation L 3

$= W_1 \times h \times Z_{1.1} = 17 \times 3.1 \times 0.455 = 24\ KN/m^2$

$Z_{4.1}$ = Lateral earth pressure at elevation L4 (Sand)

$= Z_3 + Z_{1.1} \times h \times W_{sub}$ → $(\gamma_{sat} - \gamma_w)$ or $(W_2 - W_0)$

$= 24 + 0.455 \times 18.37 \times (20 - 10)$

$= 107.6\ KN/m^2$

$Z_5 = Z_{4.1} + Z_{1.2} \times W_3 \times h$

$= 107.6 + 0.658 \times 19 \times 10 = 232.62\ KN/m^2$

$F_1 = A - B + C + D + E + F + G + H$

(Total downholding force)

$A = (L_{2.1} - L_3) \times W_1 \times Ar = 981.1 \times 3.1 \times 17 = 51703\ KN$

$B = (L_{2.1} - L_{2.2}) \times W_1 \times \left(\frac{\overline{x}^2 + \overline{y}^2}{2}\right)$

$= \frac{\overline{18}^2 + \overline{25}^2}{2} \times 17 \times 2.1 = 16940\ KN$

$C = (L_3 - L_4) \times W_2 \times Ar$

$= 18.37 \times 20 \times 981.1 = 360456\ KN$